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VII. *Account of the Dissection of a Human Fœtus, in which the Circulation of the Blood was carried on without a Heart. By Mr. B. C. Brodie. Communicated by Everard Home, Esq. F. R. S.*

Read February 16, 1809.

AN opportunity lately occurred to me of examining a human foetus, in which the heart was wanting, and the circulation of the blood was carried on by the action of the vessels only. There have been some other instances of this remarkable deviation from the natural structure; but in that to which I allude the growth of the child had been natural, and it differed much less from the natural formation than in any of those, which are on record, and I have therefore been induced to draw up the following account of it.

A woman was delivered of twins in the beginning of the seventh month of pregnancy. There was a placenta with two umbilical chords, which had their origin about three inches distant from each other. The placenta was not preserved, but Mr. ADAMS, who attended the mother in her lying-in, observed nothing unusual in its appearance. Both foetuses were born dead. They were nearly of the same size. One of them in no respect differed from the ordinary formation; the other had an unusual appearance, and Mr. ADAMS thought it deserving of examination. Through Dr. HOOPER it was put into my hands for this purpose.

The foetus measured thirteen inches from the summit of the cranium to the feet. The thorax and abdomen were surrounded by a large shapeless mass, which concealed the form of the whole upper part of the body. This mass proved to be the integuments covering the posterior part of the neck and thorax, distended with a watery fluid about three pints in quantity, contained in two cysts, lined by a smooth membrane. When the fluid was evacuated, and the cysts allowed to collapse, the foetus had nearly the natural form. Its extremities had nearly the usual appearance, except that on the right hand there was no thumb; on the left hand there was no thumb also, and only a single finger. There were three toes on the right foot, and four toes on the left foot. The external nostrils consisted only of two folds of skin, under each of which was the orifice of an internal nostril, but pervious only for about half an inch. There was a hare lip, and a cleft in the bony palate extending one third of an inch backwards.

On dissection, the cranium was found somewhat compressed by the fluid contained in the cyst behind it. The brain itself was too putrid for accurate examination, but it was of nearly the natural size, and nothing unusual was observed in it. The membranes had the natural appearance, and the nerves appeared to go off from the brain and spinal marrow nearly as usual.

In the thorax there was no heart, thymus gland, or pleura. The trachea was situated immediately behind the sternum. It had its natural appearance, and divided as usual into the two bronchia. The latter terminated in the lungs, which consisted of two rounded bodies, not more than one third of an inch in diameter, having a smooth external surface, and

composed internally of a dense cellular substance. The œsophagus had the usual situation, but it terminated in a cul-de-sac at the lower part of the thorax. The rest of the thorax was filled with a dense cellular substance; and in place of the diaphragm, there was a membranous septum between it and the cavity of the abdomen.

In the abdomen, the stomach had no cardiac orifice. The intestine was attached to the mesentery in the usual way; but it was proportionably shorter than natural. There was an imperfect cœcum, but the colon was not distinguished by any difference of structure or appearance from the rest of the intestine. The rectum had its usual situation in the pelvis. The spleen and renal capsules were small; the kidneys, bladder, penis, and testicles had the usual appearance. The abdomen was lined by peritonæum, but there was no omentum. The liver and gall-bladder were wanting.

As there was no heart, it became an object of importance to ascertain the exact nature of the circulation: for this purpose, the blood-vessels were traced with attention.

The umbilical chord consisted of two vessels only: one of these was larger than the other, and its coats resembled those of a vein, while those of the smaller vessel were thick and elastic, like those of an artery. Both of these vessels entered the navel of the child. The artery passed to the left groin by the side of the urachus, occupying the usual situation of the left umbilical artery. Here it gave off the external and internal iliac arteries of the left side, and was then continued upwards on the fore-part of the spine forming the aorta. From the aorta arose the common trunk of the right iliac artery, and the branches to the viscera and parietes of the thorax and

abdomen. At the upper part of the thorax, it sent off the two subclavian, and afterwards divided into the two carotid arteries, without forming an arch. The veins corresponding to these arteries terminated in the vena cava, which was situated on the anterior part of the spine before the aorta, and passed downwards before the right kidney to the right groin. Here it became reflected upwards by the side of the urachus to the navel, and was continued into the larger vessel or vein of the chord.

It appears therefore, that, in this foetus, not only the heart was wanting, but there was no communication of any kind between the trunks of the venous and arterial systems, as in the natural foetus, where there is a heart. The only communication between the two sets of vessels, was by means of the capillary branches anastomosing as usual in the foetus and in the placenta. The blood must have been propelled from the placenta to the child through the artery of the chord, and must have been returned to the placenta by means of the vein, so that the placenta must have been at once the source and the termination of the circulation, and the blood must have been propelled by the action of the vessels only.

It is to be understood, that the circulation in the foetus receives no propelling power from the action of the heart and arteries of the mother. This, although perfectly known to anatomists, it is proper to mention, as it may not be equally known to all the members of this Society.

It appears extraordinary, that under these circumstances, notwithstanding the circulation through the placenta must have been more languid than is natural, that organ should nevertheless have been capable of exercising its proper func-

tions, so as to produce those changes on the blood, which are necessary for the maintenance of foetal life. This may be explained by considering that in the natural foetus the umbilical arteries are branches of the general arterial system, and only a portion of the blood of the child is sent to the placenta, whereas in the foetus which I have described, the trunk of the vena cava was continued into the vein of the chord, and the whole of the venous blood circulated through the placenta, and was exposed to the influence of the arterial blood of the mother.

But the most interesting circumstance, which we learn from this examination is, that the circulation not only can be carried on without a heart, but that a child so circumstanced can be maintained in its growth, so as to attain the same size as a foetus which is possessed of that organ. This fact is contrary to what prior experience has led us to expect, as will appear from the following abstract of the authenticated cases of this species of malformation, which we find on record.

A monster, in which there was no heart, is described by M. MERY.\* There were twins, one of which was well formed, and of the usual size of a six month's child: the size of the other was not mentioned, so that no comparison could be made between them. In the latter, the head, neck, and upper extremities were wanting. There were no vestiges of a brain, nor was there any liver. The dissection of the blood-vessels does not appear to have been very accurately made, but from the general account I should suppose, that the circulation did not materially differ from that of the foetus which I have described.

\* *Histoire de l'Academie Royale des Sciences*, 1720.

Another instance of this kind is described by M. WINSLOW.\* This was also a twin, only seven inches in length. The age and size of the other child are not mentioned. In this instance there was no head, nor any vestige of brain. There were no lungs, liver, stomach, nor spleen, and only a small portion of intestine. The arterial system is described as being complete, communicating with the placenta by the umbilical vein opening into the aorta, and the umbilical arteries arising nearly as usual. In this instance there was a circle of vessels formed by the arteries only, for M. WINSLOW expressly states, that there were no veins; and however extraordinary this may appear, we cannot be otherwise than cautious in denying an observation made by an anatomist, so remarkable for his extreme accuracy and minuteness.

Dr. LE CAT of Rouen, states another case of twins† born at the end of the ninth month of pregnancy. One of them was a well formed child of the usual size; but the other was only twelve inches and a half in length. The head of the latter was very imperfect, and there was only a very minute portion of brain. The heart, lungs, liver, stomach, and spleen were entirely wanting, and there was only a small portion of intestine. The arterial system was perfect; the umbilical vein terminated in the aorta, and the umbilical arteries had their origin from the internal iliac, as usual. There is, however, an obscurity in the account of the circulation, as it is stated that there were veins, but they were not traced, nor was any communication made out between them and the arteries, or the vessels of the chord.

\* *Histoire de l'Academie Royale des Sciences*, 1740.

† *Phil. Trans.* for 1767.

Dr. CLARKE\* has given an account of a case, in which a woman, after a natural labour, was delivered of a healthy child, and also of a substance covered by common integuments, of an oval form, four inches in length, and having a separate navel string and placenta. In this substance there was one os innominatum, with a femur, tibia, and fibula. There were neither brain nor nerves; nor were there any viscera, except a small portion of intestine. The umbilical chord consisted of two vessels, an artery and a vein, both of which ramified in this substance and in the placenta.

In Dr. HUNTER's anatomical collection, there are two specimens of monsters born without hearts. In both of them the whole upper part of the body was wanting; and in neither was the exact nature of the circulation ascertained.

In each of the instances which I have quoted, not only the heart was wanting, but the fœtus in other respects was so imperfect, that it could not be considered as any thing more than a mola, or an irregularly formed living mass connected with the placenta. In particular, in all of them the brain, which may with justice be considered as affording the best distinction between a mola and a fœtus, was wanting; whereas in that which forms the subject of the present paper, the brain was nearly as large as usual, and in other respects the fœtus varied much less from the natural structure, than in any former instance.

In the cases already on record, we have seen, that wherever the size of the monster was mentioned, it was much smaller than a natural fœtus. This would have led to the supposition, that a circulation, which was carried on by the action of the vessels only, was incapable of maintaining the

\* Phil. Trans. for 1793.



natural growth of a child, had it not been found that the foetus, which I have described, though the heart was wanting, was fully equal in size to a foetus of the same age, which was possessed of that organ.

It may be observed, that in all these cases, in which the heart was wanting, the liver was wanting also. It is probable, that the action of the vessels only, without the assistance of the heart, would have been insufficient to propel the blood through the circulation of the liver, which is so extensive in the natural foetus.